

JUL 19 1966

HARVARD
UNIVERSITY

PROCEEDINGS
OF THE
CALIFORNIA ACADEMY OF SCIENCES
FOURTH SERIES

Vol. XXXIII, No. 15, pp. 481-498; 14 figs.

July 8, 1966

THE *PEDALIS*-GROUP OF *HYGROTUS*, WITH
DESCRIPTIONS OF TWO NEW SPECIES
AND A KEY TO THE SPECIES
(COLEOPTERA: DYTISCIDAE)

By

Hugh B. Leech

California Academy of Sciences, San Francisco, California 94118

In 1901 Fall described a medium-sized species of *Hygrotus* from the coast of California, *H. pedalis*, in which the middle tibiae of the male are produced inwardly at the tip (fig. 10). In 1928 Darlington added *H. thermarum* from material taken by C. T. Brues at hot springs in central and western northern Nevada; the front femora, and middle tibiae and femora of the male, are strikingly modified (figs. 1, 14). In 1938 Leech described *H. curvipes* from near the mouth of the San Joaquin River in the San Francisco Bay region of California; the middle tibiae (fig. 9) and the femora of both front and middle legs of the males are modified.

A new species closely resembling *H. thermarum* (Darlington), but from hot springs in northeastern Mono County, California, is described in the following pages. Since even the Nevada records for *H. thermarum* are some 500 miles west of the Rocky Mountains, it is of particular interest to report on a new species from a stream in northeastern Wyoming, about 175 miles east of the Continental Divide at that point. It is the largest of the group, has the front (figs. 5, 6) and middle femora of the male modified and has dual elytral punctation, a character not found in the others.

The above species I propose to call the *H. pedalis* group. Currently it may be defined as containing those species of *Hygrotus* in which the male genitalia has the apical part of the aedeagus very thin in profile, ligulate, with the tip blunt instead of pointed (compare figs. 2A and 3A). Males differ from all other described Nearctic species but one in the curiously formed front and

middle femora and tibiae. The male of *H. femoratus* (Fall) has peculiarly shaped legs (figs. 7, 11), but does not belong to this group; it is discussed later.

Hygrotus diversipes Leech, new species.

A species allied to *H. pedalis* (Fall), *H. thermarum* (Darlington), *H. fontinalis*, new species, and *H. curvipes* (Leech) by the secondary sex characters of the legs of the male, and by the male genitalia; of the size and general aspect of *H. nubilus* (Le Conte).

HOLOTYPE, male, WYOMING, NATRONA COUNTY. DUGOUT CREEK, 8.5 MILES NORTHWEST OF MIDWEST, 27.VII.1964 (H. B. Leech). Deposited in the California Academy of Sciences, Entomology.

Length 4.46 mm., width 2.1 mm. Form ovate, strongly elongate. *Color*: head rufo-testaceous, with an elongate piceous area paralleling and slightly separated from inner margin of eye, as long as and half as wide as an eye; apical palpal segment piceous except at bases; first four antennal segments pale testaceous, next four progressively darker, last three piceous. Pronotum pale rufo-testaceous, palest laterally, with a narrow longitudinal piceous mark extending from just before middle of disk to basal three-fourths. Elytra pale yellowish testaceous except as follows: each elytron with an oblique elongate semitransparent area just before base, from near suture to near humerus; suture narrowly piceous; a small elongate fuscous sublateral spot at basal quarter; and a large fuscous mark extending from basal third to apical sixth, one-third longer than broad, well separated from suture, tridentate anteriorly, broad and a little emarginate posteriorly, bulging on its outer side at middle, and with a tiny pale inclusion behind middle. Epipleura and legs yellowish testaceous, pro- and mesofemora infusate apically. Metasternum, hind coxal plates, and abdomen rufo-piceous to black.

Head shining, finely punctate, punctures separated by a little more than their own diameters, except in a transverse area just before an imaginary line joining hind margins of eyes, where they are coarser, closer set, and in short series. Clypeus not margined. *Pronotum* shining, punctation about as on much of head, sparsest on a slightly inflated area near each side of front part of discal piceous mark; with a shallow, narrow longitudinal impression in front half of discal piceous mark. Pronotum wider at base than at apex (8 : 5.5), sides straight to near front angles, gradually converging; hind angles slightly obtuse; lateral marginal bead narrow, about as wide as a facet of eye. *Elytra* shining, basal half finely, densely punctate, punctures separated by about their own diameters; subsutural, discal, humeral, and sublateral longitudinal series of coarse punctures apparent, the punctures two to three times as large as fine ones between series; in addition, there are irregularly scattered coarse punctures among fine ones on interspaces in basal half of elytra, but in apical half almost all punctures are large. Epipleura finely, densely punctate.

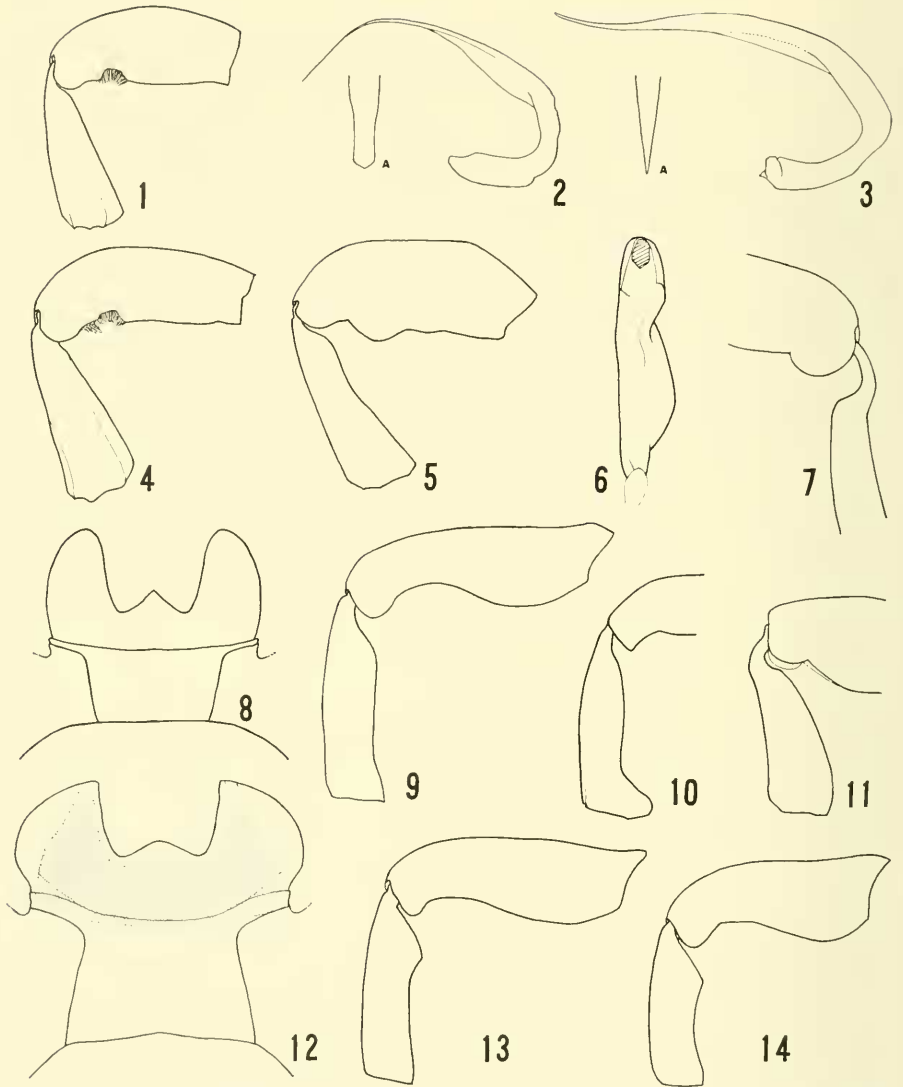
JUL 19 1966

HARVARD
UNIVERSITY

Metasternum coarsely punctate laterally, many of punctures behind meso-coxae confluent and longitudinally serial; posterior half of midmetasternum shining, impunctate, bordered by a linear area of fine punctures, and lateral to this with another impunctate area. Metacoxal plates coarsely, closely punctate except near posterior margin where surface is merely finely reticulate. Metacoxal lines together lyriform, intralineal area with line of coarse punctures at each side, rest with greatly elongated small punctures; median line impressed. First abdominal sternum as coarsely punctate as are metacoxal plates; second sternum nearly as coarsely punctate laterally, sparsely and more finely toward median line; following sterna progressively more finely punctate, four and five each with a few long golden hairs arising from a puncture on median line near middle. Prosternal process broadest at middle, margined, tectiform along median line, apex pointed.

Protrochanter with line of golden hairs along ventral edge. Profemur broad, inflated at middle on anterior face, ventral side coming to an edge, sinuate in outer third, edge outcurved at apical third, then broadly, shallowly notched before apex (figs. 5, 6), a few short golden hairs in emargination; posterior face with lower third opaque, crescentically emarginate for reception of tibia; lateral wing of apical groove in which tibia articulates, very large. Protibia as an oblique-topped elongate triangle, apical angles rounded, inner margin slightly sinuate (fig. 5), posterior face smooth, inflated, lower margin except near base with a compact linear brush of golden hairs. Protarsi narrow, as wide as first segment of metatarsus; claws simple, anterior one a little shorter, broader, and more strongly curved at base than its fellow. Mesotrochanter as in protrochanter. *Mesofemur* broad, flat, widest at basal two-sevenths, where it is a little more than twice as wide as an epipleuron near base, lower edge slightly sinuate; lower side flat, as wide as an epipleuron, posterior edge with thin fringe of golden hairs; posterior lateral wing of apical groove large. Mesotibia simple. *Metatrochanter* almost one and one-half times as long as broad, not bearded, apex bluntly pointed. Metafemur strongly narrowed at base, anterior margin broadly concave in basal third, anterior (lower) face inflated medially, lightly impressed on anterior half at apical three-fourths, sides nearly parallel in median two-thirds; surface shining, with series of short oblique impressions in basal two-thirds; thence finely reticulate; an inconspicuous longitudinal median line of setose punctures present. Metatibia gradually widening from base to apex, arcuate, with concavity outward; outer face near apex of anterior margin with a few punctures, each with a small spine. *Male genitalia*: aedeagus curved, strongly dorsoventrally flattened and exceedingly thin in apical three-elevenths, ligulate; apex blunt, subangulate (figs. 2, 2A).

ALLOTYPE, female, same data as for holotype; in California Academy of Sciences, Entomology. Length 4.2 mm., width 2.1 mm. Almost exactly like



FIGURES 1-14. Structures of males of *Hygrotus* species. Fig. 1. Front femur and tibia of *H. thermanum*. Fig. 2. Profile of aedeagus of *H. diversipes*; 2A, ventral view of apical portion. Fig. 3. Same as 2, for *H. nubilus*. Fig. 4. Front femur and tibia of *H. fontinalis*. Fig. 5. Same, *H. diversipes*. Fig. 6. Ventral view of front femur of *H. diversipes*, apex and fossa for tibial insertion at top. Fig. 7. Apex of femur and base of tibia of hind leg of *H. femoratus*. Fig. 8. Mentum and submentum of *H. curvipes*. Fig. 9. Middle femur and tibia of *H. curvipes*. Fig. 10. Same, *H. pedalis*. Fig. 11. Front tibia and femur of *H. femoratus*. Fig. 12. Mentum and submentum of *H. pedalis*; the stippled area is semicircularly impressed just anterior to the transverse curved sutures. Fig. 13. Middle femur and tibia of *H. fontinalis*. Fig. 14. Same, *H. thermanum*.

the male, except for sex characters; head and prothorax slightly darker than in type; elytra with rufous tinge adjacent to suture; large elytral infuscation bidentate anteriorly, the outer of the two projections larger, extending forward to level of small sublateral spot. Profemur with slight projection on lower anterior face at apical third, and small notch between that and apex; mesotibia broad, flat, lower margin distinctly sinuate. Metatibia less strongly arcuate than in male.

PARATYPES, eight males, ten females, all with the same data as the type. Paratypes will be placed in the following collections: United States National Museum, Canadian National Collection, F. N. Young, R. D. Anderson.

VARIATION. One paratype male is 4.6 mm. long, four are of the same length as the type, two are 4.2 mm. and 4.3 mm., respectively, and one is only 3.75 mm. The paratype females vary in length from 4.0 to 4.25 mm., most of them being near the upper limit. There is an appreciable variation in elytral coloration, but because all specimens in the type series are teneral it is hard to assess. In both the holotype and allotype there is a semitransparent area on each elytron near the base, but this is not a taxonomically significant character, even though some paratypes show it. Other paratypes have extensive and irregular semitransparent areas, or none at all; one has the right elytron semitransparent except narrowly near the suture, and the left elytron more yellowish testaceous (the usual fuscous markings are present on both). One specimen with semitransparent elytra was soaked in ether for a few moments, and then dried; parts of the elytra became yellowish testaceous again for a time, but later faded out. The facts that all specimens are teneral, and that they were placed in 70 per cent alcohol immediately upon being collected, may have something to do with this coloration.

There is considerable variation in the curvature (as in the holotype) or straightness (as in the allotype) of the metacoxal lines in the anterior two-thirds of their course, but the variation is not sex-linked.

One paratype female has a teratological right antenna. It has eight instead of 11 segments; segments 1 to 7 and 11 appear to be normal, but 8 to 10 have fused to form an elongate, somewhat irregular segment about as long as 8 and 9 together would normally be.

REMARKS. *Hygrotus diversipes* is clearly to be associated with *H. pedalis*, *H. thermarum*, *H. fontinalis*, new species, and *H. curvipes* by the peculiarly formed femora and tibiae of the males. In addition, each of these species has the aedeagus of the male ligulate, recurved, and blunt apically, while all other Nearctic species known to me have the aedeagus ligulate or acicular, but always sharply pointed in dorsal or ventral view (compare figs. 2A, 3A). However, *H. diversipes* will not trace readily to couplet 8 of Fall's key, where *H. pedalis* is placed. It goes easily to division 5 but not through it to 7 and 8, because the elytral punctuation is obviously dual; neither does it fit the first

choice in division 5, because the elytra have well-defined markings. With males at hand the crural characters will place it (figs. 5, 6); females may be associated by the dual punctation of the midelytral disk, the elytral markings, the finely and densely punctate epipleura, and the slight bump and associated small emargination near the outer end of the lower front margin of the profemora.

Two species resembling *H. diversipes* in facies occur in the same stream with it, *H. nubilus* (Le Conte) and *H. patruelis* (Le Conte). *Hygrotus nubilus* is well epitomized by Fall (1919, p. 15): "The elongate form, rather large size [4.0 to 4.4 mm.], evenly rather finely punctate elytra, and pale head, form a combination of characters which separate this species from all other except *femoratus*, . . ."; in using division 3 of Fall's key (*loc. cit.*, p. 2) one must guard against tracing specimens to the third choice, rather than to the second as necessary, since many examples have the elytral markings decidedly vittiform. *Hygrotus patruelis* is a little smaller, 3.5 to 4.0 mm. long; the head is infuscated on each side near the eyes, and as in *H. nubilus* the protarsi of the male are much wider than those of the female and have the anterior claw thickened and abruptly bent.

Males of *H. diversipes* may be separated from those of both of Le Conte's species by their modified front femora (figs. 5, 6), narrow protarsi, and simple anterior claw. Females of *H. diversipes* may be recognized by their dual elytral punctation, the basic fine punctation of which is much smaller than that of *H. nubilus* or *H. patruelis*. The shallow preapical profemoral notch and the broad flat mesotibiae with lower (inner) margin slightly but distinctly sinuate, are also diagnostic.

The type locality of *H. diversipes* is Dugout Creek, Natrona County, Wyoming. This stream is a tributary of Salt Creek, *i.e.*, of the Missouri River drainage system. In late July, 1964, the stream at Highway 87 was a series of disconnected pools in a clay and gravel bed. The water was mineralized enough to have left a white deposit on the shores and stones as it evaporated, but contained young fish, apparently those of the flathead chub, *Platygobio gracilis* (Richardson) (determination by W. I. Follett).

Hygrotus pedalis (Fall).

Cælambus pedalis FALL, 1901. Calif. Acad. Sci., Occ. Papers, no. 8, p. 212.

Coelambus pedalis Fall, FALL, 1919. N. Amer. spp. *Coelambus*, pp. 3 (key), 13-14.

Cælambus pedalis Fall, LEECH, 1938. Pan-Pacific Ent., vol. 14, no. 2, p. 86.

Cælambus curvipes LEECH, 1938 (*partim*). Pan-Pacific Ent., vol. 14, no. 2, pp. 85, 86.

Hygrotus pedalis (Fall), LEECH, 1956. In: Aquatic Ins. Calif., p. 316.

Hygrotus pedalis is more broadly ovate than other species in the group, notably obtusely rounded anteriorly because of the large head; it is also the darkest in color. Females may be separated from those of other species of the genus in coastal California by a combination of features. The elytra

are finely, very densely punctate except for the usual longitudinal series of coarser punctures; the head is dark basally, without a pale spot at the middle (teneral specimens are not typical); the epipleura are finely, densely punctate over the whole area except in front of the basal carina; the mesofemora are darkest in the basal two-thirds.

Females of *H. pedalis* and *H. curvipes* are structurally very similar, and upon collecting a pure culture of the former in 1954, I realized that the "form C" of the female in my description of *H. curvipes* was in fact that of *H. pedalis*. Females of *H. pedalis* may be distinguished by the darker head, and by the mesofemora being darkest in the basal two-thirds; in *H. curvipes* the femora are darkest in the apical quarter. See also the following comments.

There are two other characters in *H. pedalis*, one especially striking in the male, which have not been noted before. The surface of the mentum, instead of being shiny like the surrounding areas is in all other species of *Hygrotus* which I have examined, is here differentiated, very finely granular and yellowish white in color, giving a peculiar "cheesy" appearance. In the male almost the entire mentum is semicircularly impressed, the curved posterior margin of this impression encroaching upon the usual straight transverse suture separating it from the submentum (compare figs. 8, 12). The lateral lobes of the mentum are very broadly rounded anteriorly; the outer anterior part and a small median area just behind the labial palpi have the surface shining, not granular. In the female the mentum is smaller, not semicircularly impressed, the lateral lobes are not so expanded, and the differentiated area is small and harder to see. Nevertheless, once the feature is recognized, it is of great help in identification.

The hind coxal plate of *H. pedalis* is more coarsely punctate than in other species of the group; the area between the punctures are mostly convex, giving a subrugose appearance. Starting at each outer margin beside the epipleura and extending halfway across the plate toward the middle coxa there is an impression; the punctures in it are smaller and confluent. This oblique narrow impression will separate both sexes of *H. pedalis* from any other species of the genus within its distribution.

Fall recorded *H. pedalis* from Pomona (type), Riverside, Naples, and San Diego in southern California, and Vine Hill, Contra Costa County, in the San Francisco Bay region. A male from Riverside, dated 5.6.90 and from the type series, was given to me by Mr. Fall in 1937 and is before me. I have seen examples from the following additional localities: Poway, San Diego County (F. E. Blaisdell); Pasadena, Los Angeles County, April and May (A. Fenyés); Sunol, Alameda County, September 14, 1919 (J. O. Martin); Oakley, Contra Costa County, September 5, 1936 (H. B. Leech; female form "C" of *H. curvipes* paratypes), and August 21, 1938 (E. C. Van Dyke); Danville, Contra Costa County, June-July, 1951 (F. X. Williams); Martinez, Contra

Costa County, September 17, 1962 (R. Brown); also from the following eight localities all in Marin County: Smith Lake, Manor, November 21, 1955 (H. B. Leech); Novato Creek, 2 miles south of Novato, February 21, 1954 (H. B. Leech); Olema, August 14, 1946 (H. P. Chandler); Marshall, October 20, 1963 (H. B. Leech); Tamales [sic!], Bay near Marshalls, September 11, 1938 (E. C. Van Dyke); Stemple Creek, 1.5 miles north of Tomales, September 28, 1964 (H. B. Leech); Dillon Beach, June 24 and October 19, 1963 (H. B. Leech); Inverness, July 21, 1963 (P. H. Arnaud, Jr.), in small fresh-water pond with extensive algal mats.

The Oakley specimens were from a cattle-fouled pool in which *Typha* sp. grew; those from Stemple Creek in a cattle-fouled pool in the dry stream bed. Novato Creek is affected by the tides and was brackish in the part sampled; the Dillon Beach specimens were taken from pools near the foot of the large Sand Point dunes and only a few above sea level. The single example from Marshall was in a pool in a flowing stream, just above the tidal effect.

Hygrotus curvipes (Leech).

Calambus curvipes LEECH, 1938. Pan-Pacific Ent., vol. 14, no. 2, pp. 84-86.

Calambus pedalis Fall, LEECH, 1938 (*partim*). *Loc. cit.*, p. 86.

Hygrotus curvipes (Leech), LEECH, 1956. In: Aquatic Ins. Calif., p. 316.

As explained under *H. pedalis*, the type series of *H. curvipes* actually contained several females of the very similar *H. pedalis*. The middle femur and tibia of a male of *H. curvipes* are shown in figure 9.

To the best of my knowledge *H. curvipes* has been taken only at the type locality, a shallow, muddy pool at Oakley, Contra Costa County, California. I collected the original series on September 5, 1936; Dr. E. C. Van Dyke went to the pond on August 21, 1938, and obtained males and females of both *H. curvipes* and *H. pedalis*. The diagnostic characters are given under the latter species.

Hygrotus thermarum (Darlington).

Coelambus thermarum DARLINGTON, 1928. Psyche, vol. 35, no. 1, pp. 1-3.

Coelambus thermarum Darlington, BRUES, 1928. Proc. Amer. Acad. Arts & Sci., vol. 63, no. 4, p. 170. BRUES, 1932. *Loc. cit.*, vol. 67, no. 7, p. 259.

Calambus thermarum Darlington, LEECH, 1938. Pan-Pacific Ent., vol. 14, no. 2, p. 86.

Hygrotus thermarum should have been included in my 1956 key to the California species, but I overlooked Brues's 1932 record for a specimen from the outflow of a hot spring 5 miles east of Cedarville, Modoc County, in the northeastern corner of California. Thanks to the kindness of Dr. P. J. Darlington, Jr., of the Museum of Comparative Zoology, I have seen the beetle; it belongs indeed to *H. thermarum* (as would be expected on dis-

tributional grounds), and is a female. The mesotibia of a male is shown in figure 14.

In his 1932 paper (p. 259) Brues lists the temperature, specific gravity, and pH of the water in which he took this species.

Spring number and location	Temperature	Specific gravity	pH
20. Twenty-nine miles south of Winnemucca, Nevada	38.0° C.	1.0014	8.6
23a. About 36.5 miles south of Battle Mountain, Nevada	30.0°	1.0021	8.6
103. Forty-five miles northeast of Austin, at Cortez, Nevada	44.5°	1.0041	8.5
113. Soldier Meadows, Nevada, about 35 miles north of Gerlach	19.2°	1.0007	8.8
120b. Five miles east of Cedarville, California	28.4°	1.0034	8.2

It is clear that water temperature is not a deciding factor in the beetles' occurrence, although the 44.5° figure is remarkably high for a carnivorous species, a point made by Tuxen (1944). Indeed, Brues found only two species of water beetles surviving in water above 45°, and none above 46°. Of more significance so far as *H. thermarum* is concerned would be a knowledge of the water temperature at which the immature stages develop successfully. The pH figures are near the optimum for species occurring in hot springs. Of Harney Lake Hot Springs, Oregon, Malkin (1959, p. 34) reports three species of water beetles ". . . swimming cheerfully along the shore of the hot springs in the temperature as high as 52.2° Centigrade."

Specimens have been seen from the following Oregon localities: Twelve miles south of Blue Mt. Pass, Malheur County, July 20, 1956 (Hugh B. Leech; flying specimens attracted to the light of a "Coleman" lantern); hot spring 4 miles north of Fields, Harney County, July 16, 1957 (Ken Goeden); Hot Lake, 5 miles north of Fields, Harney County, July 17, 1959 (J. D. Lattin).

Also before me are two females from a freshwater pool on the southeast shore of Lake Abert, Lake County, Oregon, July 17, 1950 (H. B. Leech). In Hatch's key to the species of the Pacific Northwest (1953, pp. 198-202) they run to *H. bonnelli* Hatch, 1951, and agree well with the original description. It would be desirable to verify that they belong to *H. thermarum* by the collection of males. Hatch based *H. bonnelli* on a pair from alkaline Lake Abert, but did not mention any peculiarities in the legs of the male; however, it may be noted that both sexes of *H. thermarum* run to *H. bonnelli* in his key.

A male from a spring at Deep Springs, Inyo County, California, August 19, 1963 (H. B. Leech) extends the known distribution southward by some 180 airline miles from the nearest Nevada locality, and is about 90 miles south of the type locality for *H. fontinalis*. The 180 miles does not seem impressive until one considers the possibilities for these beetles of finding suitable habitats in a desert area where sources of water of any sort are small, and widely and irregularly scattered. There must be colonies in the intervening area.

Hygrotus fontinalis Leech, new species.

A species closely resembling *H. thermanum*, differing chiefly in the structure of the legs. Known from north central Mono County, California.

HOLOTYPE, male, CALIFORNIA, MONO COUNTY. TRAVERTINE HOT SPRINGS, 2 MILES SE. OF BRIDGEPORT, ALTITUDE 6,700 feet, 11.VIII.1962 (H. B. Leech). Deposited in the California Academy of Sciences, Entomology.

Length 3.85 mm., width 1.95 mm. *Form* ovate, elongate. *Color*: Head black, dark rufo-piceous near front margin, paler above antennal insertions, with a small reddish yellow spot on vertex; labrum and palpi reddish yellow, the former infuscate at middle, the latter apically; first four antennal segments pale testaceous, remainder progressively darker to piceous. Pronotum piceous, vaguely paler laterally. Elytra pale yellowish brown, slightly more than basal fifth of discal area semitransparent, suture narrowly piceous; each elytron with an irregular, elongate infuscate cloud from basal fifth to apical sixth, the cloud bidentate anteriorly, its median lateral projection nearly disconnected; a faint sublateral infuscate mark shows at basal fifth; lateral margin along an area opposite first to about middle of sixth abdominal sterna, narrowly piceous. Epipleura dull yellowish brown from base to opposite first abdominal sternite, then piceous to apex (*i.e.*, adjacent to about middle of sixth sternum and opposite the internal elytral ligula). Prolegs rufo-piceous, femora dark, tibiae paler, especially at base; mesofemora black, mesotibiae rufo-piceous, tarsi infuscate.

Head shining, finely and somewhat unevenly punctate, puncture finer and denser in a depressed area inward from emargination near front of each eye, and in a narrow longitudinal area near inner margin of each eye. Clypeus not margined. Pronotum shining, finely and rather evenly closely punctate except on slightly tumid sparsely punctate part on each side of middle of disk; anteriorly and posteriorly from a point just outward from the tumid areas, punctures are coarser, as are usual transverse series paralleling anterior margins; middle of disk with a short longitudinal impressed mark. Pronotum wider at base than at apex (7:4.75), sides weakly arcuate; hind angles obtuse; lateral marginal bead narrow, not as wide as two facets of an eye.

Elytra shining, finely densely punctate, punctures of nearly uniform size and spacing from base to near apex, except for the usual longitudinal series of coarser ones (subsutural, discal, humeral, sublateral), separated by less than their own diameters. Epipleura punctate, a little more sparsely and finely so than elytra. *Prosternal process* narrow, widest near base, weakly margined, median line tectiform, apex pointed, almost acuminate. Protrochanter with an inconspicuous line of hair along ventral edge. *Profemur* with upper side weakly arcuate from base toward apex (fig. 4), lower margin nearly straight, anterior face strongly inflated in middle part, broadly impressed on lower two-thirds before apex, its surface finely reticulose, the impression funneling to a deep notch in anterior lower margin, notch set with short stiff golden setae (fig. 4); there is a small tooth just posterior to it; lower edge of median part of femur flattened, with slight posterior slope, surface finely granular, its posterior edge fringed with long golden hairs. Protibia widest apically, lower anterior corner flattened and turned under; posterior face with longitudinal brush of dense, long golden hairs arising from a sinuate line along middle; trochanter with a thin line of short hairs along ventral edge; tarsus narrow, segments hardly broader than those of female, basal segment broadest, next two progressively narrower; claws simple, of equal length, anterior one very slightly more curved than its fellow. Mesotrochanter with an inconspicuous line of hairs along ventral edge. *Mesofemur* flattened, dorsal margin arcuate, ventral margin strongly arcuately lobed in basal third, narrowest in apical third, outer angles produced downward (fig. 13); ventral side broadened, impressed to receive subbasal projection of mesotibia, surface of broadened area finely granulate; ventral margin between broadened area and trochanter with fringe of long silky hairs. Mesotibia very slightly arcuate, nearly parallel-sided in apical half, ventral side lobately produced on anterior margin at basal two-thirds, thence rapidly narrowed to base (fig. 13); ventral margin broadening from base to apex, somewhat flattened, and with a line of long golden hairs starting behind lobe on anterior edge; anterior face, in lower apical half punctate and with a patch of golden hair; upper edge of posterior face with a line of fine golden hairs. *Metafemur* with anterior margin shallowly concave in basal half, sides nearly parallel in median two-thirds; surface shining, with series of short oblique impressions on median area, finely reticulose in apical quarter; an inconspicuous longitudinal median line of setose punctures present. Metatibia gradually widening from base to middle, thence nearly parallel-sided to apex; arcuate, with concavity outward; outer face near anterior margin with a few punctures, each with a spine. *Metasternum* very finely punctate along each side of median line, impunctate on an area lateral of this, side wings coarsely punctate; median line impressed more deeply posteriorly. Metacoxal plates coarsely punctate except for an area paralleling hind margin,

comprising half the width of the coxa internally and narrowing externally, which is impunctate; metacoxal interlineal area three-quarters as wide at narrowest point (before metacoxal lobes) as anteriorly at hind margin of metasternum, punctate, median line impressed; metacoxal lines slightly curved. First two abdominal sterna as coarsely punctate as are metacoxal plates, remaining sterna more densely but much more finely punctate; sterna 4 and 5 each with a few golden hairs arising from a puncture on median line near middle. *Male genitalia*: Aedeagus curved, strongly dorsoventrally flattened and exceedingly thin in apical three-elevenths, ligulate; apex blunt subangulate.

ALLOTYPE, female, data the same as for the holotype; in California Academy of Sciences, Entomology. Length 3.80 mm., width 1.92 mm. Almost exactly like the male except for sex characters; head and pronotum slightly paler, elytral markings a little more extensive.

PARATYPES, 9 males, 16 females, all with the same data as for the holotype. Also 25 males and 54 females, all topotypical but collected on August 15, 1963. Paratypes will be distributed to the United States National Museum, The Canadian National Collection, the British Museum (Nat. Hist.), the Museum of Comparative Zoology, F. N. Young, R. D. Anderson, and M. H. Hatch.

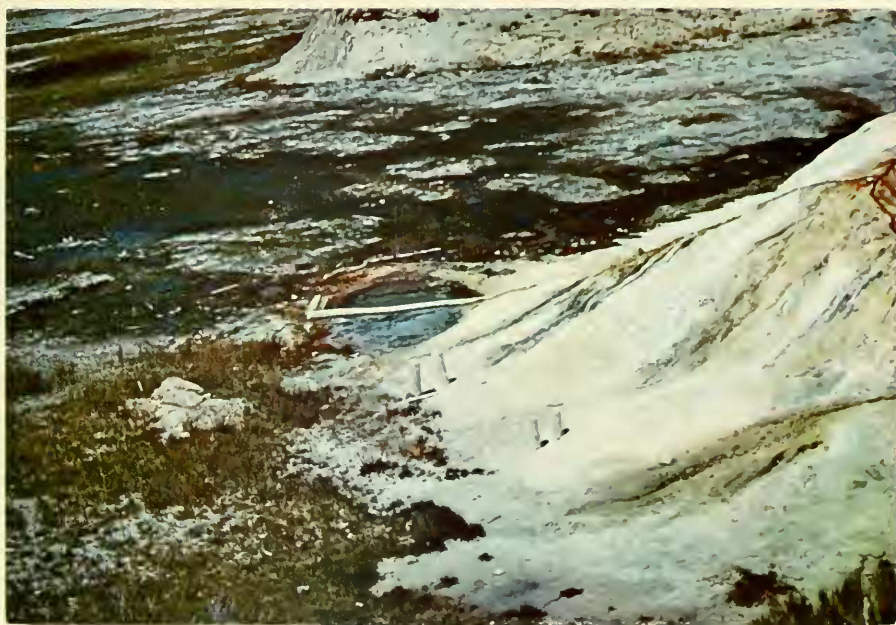
VARIATION. There is very little variation among the specimens. In some, anterior prolongations of the infusate markings may extend to the basal tenth of the elytra, but are never more reduced than in the holotype; they are usually more extensive in the females than in the males. The smallest female is 3.60 mm. long, the largest 3.90 mm.

REMARKS. *Hygrotus fontinalis* closely resembles *H. thermarum* but may be recognized in both sexes by the longer front and middle legs (figs. 4 and 13 *vs.* 1 and 14), and by the curvature of the upper side of the front femur (fig. 4 *vs.* 1). Males of *H. fontinalis* have the same type of femoral and tibial modifications found in *H. thermarum* and *H. curvipes*, but the profemoral notch is larger, deeper, and more strongly ciliate than in Darlington's species, while the body shape, the bicolored front and middle legs, and differences in habitat and distribution mark *H. curvipes*.

→

PLATE 1. UPPER FIGURE. Detail of the left center foreground of the lower picture, from a different angle. The pool with a small log across it is the type locality for *H. fontinalis* as it was in August, 1963. The species also occurs in the shallow sedge pools just beyond.

LOWER FIGURE. General view of three tufa ridges at Travertine Hot Springs, about 2 miles southeast of Bridgeport, Mono County, California. The tiny hot spring mentioned in the text is in the crack at the top of the white section in the center foreground. Water is channeled to the right to the "bathtub," or to the left to the pool which is the type locality for *Hygrotus fontinalis*. The trees in the background are singleleaf pine (*Pinus monophylla* Torrey) and western juniper (*Juniperus occidentalis* Hooker); altitude 6,700 feet.



Hygrotus fontinalis occurs in the runoff pools from hot springs in a limestone outcrop. The type locality is a most interesting spot on slopes of andesitic lava, with a background of hills covered with the singleleaf pine (*Pinus monophylla* Torrey) and western juniper (*Juniperus occidentalis* Hooker), at an altitude of 6,700 feet. I am indebted to Mrs. Grace Crocker, one of the owners of the land, for permission to collect there.

The prominent ridges of calcareous tufa, or in more colorful language banded onyx marble, have apparently formed as mineral-laden waters flowed out of long fissures, which have narrowed with height as the sides built up. To one familiar with the signs of pocket gophers (*Thomomys* spp.) in the western mountains, it is easy to imagine a giant race at work during the winter, filling their snow tunnels with excavated dirt, the "gopher cores" of summer (see Storer and Usinger's "Sierra Nevada Natural History," fig. 23 on page 329). The low gray ridges are shown in the lower figure of plate 1. A longitudinal vertical fissure can be seen at the top of the middle ridge, while the white section in the foreground is still actively growing by deposit from a tiny hot spring in the crevice.

The above-mentioned photograph was taken in 1963. It is interesting to compare it with one made in the period 1908-1910, and comprising figure A, plate IX, of G. A. Waring's 1915 report on the springs of California. He stated the flow from the little hot spring to be about one gallon a minute. "It deposits lime carbonate on troughs and barrels which have been arranged so that the water can be used in preparing sheep dip. This deposit is said to form at the rate of nearly an inch a month."

Analysis of water from spring from crevice in travertine ridge. Hot Springs near Bridgeport, Mono County, California. Analyst and authority, F. M. Eaton (1910). Constituents are in parts per million.

Temperature	64° C.	(148° F.)
Properties of reaction:		
Primary salinity		48
Secondary salinity		0
Tertiary salinity		0
Primary alkalinity		44
Secondary alkalinity		8
Tertiary alkalinity		6
Constituents	By	Reacting
	weight	values
Sodium (Na)	1,109	48.22
Potassium (K)	35	0.90
Calcium (Ca)	60	3.01
Magnesium (Mg)	19	1.56

Iron (Fe)	}	1.8	0.06
Aluminium (Al)			
Sulphate (SO ₄)		939	19.55
Chloride (Cl)		214	6.04
Carbonate (CO ₃)		844	28.14
Silica (SiO ₂)		89	2.96
		<hr/>	
		3,310.8	-----
		<hr/>	
Carbon dioxide (CO ₂)		Present	Present

The site is currently known as "the bathtub," because someone has excavated a neat hole of the size and shape of a bathtub at the southeast corner of the tufa ridge. It shows in the lower photograph, at the right-hand end of the narrow iron-stained water course leading from the little hot spring at the top. At the left foot of the ridge there is a larger natural pool formed by an independent cool spring, but it also receives most of the water from the hot spring when it is not flowing to the bathtub. This pool shows in Waring's photograph (as do the wooden posts in the upper of my two photographs, but in 1910 they supported a long squared timber), and is the actual type locality of *Hygrotus fontinalis*. Normally the water is cool, the bottom muddy and soft with a flocculent deposit, easily roiled, and beetles are common throughout.

When not wanted for the bathtub the water from the hot spring can be returned to its normal course by plugging the narrow cut channel with mud and stone, as shown in the photographs. In 1962 it flowed broadly over the side of the mound to the pool below. On the sodden slope were many dead specimens of *H. fontinalis*, killed by the hot water when they landed in it, attracted no doubt by its glistening wetness as they flew nearby.

Unfortunately, the bathtub holds only one person, so in 1963 some late visitor, also wanting to relieve his arthritic pains by soaking in the hot mineralized water, cut a direct channel from the hot spring to the type-locality pool. It worked—the water was hot and I saw a man in it. In fact it was so hot that all but a few beetles around the edges were killed. Luckily a population continues in adjacent sedge-covered overflows, which show in the upper photograph as dark places among the white carbonate deposits.

At least five species of aquatic beetles have been taken with *H. fontinalis* at the type locality: Dytiscidae, *Bidessus* sp., a form belonging to the *B. affinis* complex; *Hygrotus tumidiventris* (Fall); *Deronectes striatellus* (Le Conte); Limnebiidae, *Ochthebius bruesi* Darlington; Hydrophilidae, *Enochrus* sp.

Travertine Hot Springs is some 10½ miles west of Nevada, and about 175 miles southwest of the nearest reported locality for *H. thermarum*. The latter species I have taken in southeastern Oregon, flying to the light of a

"Coleman" gasoline lantern at some distance from a known hot spring, so *H. fontinalis* can be expected in any suitable springs in the Bridgeport area. On August 15, 1963, I took a female attracted to light at The Hot Springs, a group of springs about a mile and a half south of the type locality, and to my knowledge the species occurs in at least the largest (called Big Hot) warm pool there.

Hygrotus femoratus (Fall).

Coelambus femoratus FALL, 1901. Calif. Acad. Sci., Occ. Papers, vol. 8, p. 212.

Coelambus femoratus Fall, FALL and WICKHAM, 1907. Trans. Amer. Ent. Soc., vol. 33, nos. 2 and 3, p. 162. FALL, 1919. N. Amer. spp. Coelambus, p. 4 (in key), 15-16 (description).

By chance described on the same page of Fall's 1901 paper, though widely separated in his 1919 revisional study, *H. femoratus* and *H. pedalis* were the only species known to have the femora and tibiae of the males modified. With the descriptions of *H. thermarum* and *H. curvipes*, and in this paper of two more species, all having peculiarly shaped front and middle legs, it seemed probable that *H. femoratus* also belonged to the *H. pedalis* group. *Hygrotus femoratus* closely resembles *H. nubilus*, and apparently both occurred at Albuquerque, New Mexico (Fall and Cockerell, *loc. cit.*, under *Coelambus nubilus*: ". . . The Albuquerque insect was, at least in part, *femoratus*.") *Hygrotus diversipes*, new species, also resembles *H. nubilus* and was taken with it in central Wyoming.

Fall described *H. femoratus* from a single male, and in 1919 mentioned that "A second example, taken at the same place is a female and is probably correctly associated; it is slightly larger and noticeably duller than the male." These are the only specimens recorded in over 60 years.

Through the kindness of Drs. P. J. Darlington, Jr. and J. F. Lawrence of the Museum of Comparative Zoology, I have been able to study the type. The femoral apices of all three pairs of legs are distinctive, and unlike those of any other described Nearctic species (figs. 7, 11); Fall calls them laminate, but this is hardly true. The lateral wings of the apical articulation are big (though not larger than in *H. diversipes*), unusually thick, and inflated internally so there is only a narrow, shallow groove for the pedunculate tibial bases to fit into. The middle and hind tibiae are almost parallel-sided after the pedunculation, but the front tibia gradually enlarges toward the apex.

All species grouped in this paper with *H. pedalis* have one feature in common, in addition to the tibial and femoral modifications: the aedeagus of the male is always very thin and blunt apically, ligulate (fig. 2A). In all other Nearctic species of *Hygrotus* known to me the aedeagus is thin or acicular apically but always pointed (fig. 3A). It is thus a great surprise to find that *H. femoratus* belongs to the second group; in fact, the aedeagus is very like that of *H. nubilus* (fig. 3), but more gradually narrowing apically.

It seems probable that this aedeagal character is more significant of relationships than the leg modifications, so I do not include *H. femoratus* in the *H. pedalis* group. In my key it will not fit either choice in the first couplet; the elytral punctures are of almost uniform size and distribution, but the anterior protarsal claw of the male is short, broad, and strongly curved as in *H. nubilis*. In the male all femora have the apical articular flanges large, and the tibiae pedunculate basally (figs. 7, 11).

The following key is an attempt to enable students to place both males and females of species of the *H. pedalis* group. Males are most easily identified by comparison with the drawings of femora and tibiae (figs. 1, 4, 5, 6, 9, 10, 13, 14).

KEY TO THE SPECIES OF THE *HYCROTUS PEDALIS* GROUP

1. Elytral punctures (other than the usual longitudinal series of coarser ones) fine, dense, of almost uniform size and distribution from base to apex; anterior protarsal claw of male simple and like posterior claw; profemur of male not as in figures 5, 6; mesotibia obviously modified (figs. 9, 10, 13, 14). Nevada, Oregon, California 2
- 1'. Elytral disk with intermixed fine, dense, and scattered coarse punctures on the areas between the usual longitudinal series of subsutural, discal, humeral, and sublateral coarse punctures; anterior protarsal claw of male a trifle shorter, broader, and more sharply bent than posterior claw; profemur of male as in figures 5, 6, mesotibia slightly sinuate on lower margin. Wyoming *H. diversipes*, n. sp.
- 2(1). Profemur of male shining, with a funneled impression on anterior face ending in a ciliated notch at apical third of lower edge (figs. 1, 4); ventral half of posterior face of protibia covered with long golden hairs, mesotibia not strongly produced inwardly at apex (figs. 9, 13, 14); mentum shining, its median area not differentiated (fig. 8); head with median pale spot near base; hind coxal plate not impressed at outer edge 3
- 2'. Profemur of male not notched, but with outer half of anterior face broadly, shallowly impressed, and surface finely granulate; protibia without patch of golden hairs on posterior face; mesotibia of male produced inwardly at apex of lower side (fig. 10); median area of mentum differentiated (extensively in the male, fig. 12), its surface dull, anterior lateral lobes large, very broadly rounded; head normally without pale spot at base; hind coxal plate with an oblique impression starting adjacent to the epipleura. Coast of California, San Diego north to at least Marin County *H. pedalis* (Fall)
- 3(2). Mesotibia of male almost parallel-sided in apical half, then lobately produced on lower (inner) margin and obliquely narrowed to base (figs. 13, 14). Pronotum usually uniformly rufo-piceous to piceous, pale only near lateral margins; pro- and mesofemora uniformly colored. From hot springs in northwestern Nevada, southeastern Oregon, and the northeastern edge of California 4
- 3'. Mesotibia of male almost parallel-sided in apical two-thirds, thence obliquely narrowed to base on ventral side (fig. 9). Pronotum usually pale with piceous mark in middle of disk; pro- and mesofemora usually strongly bicolored, basal three-fourths testaceous, apical fourth piceous to black. As yet known only from